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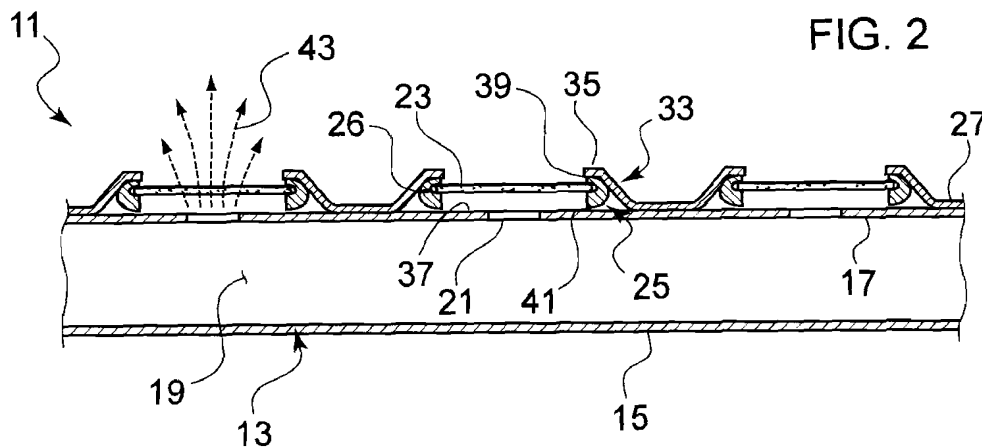
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**(54) Title:** ANTENNA COVER FOR MICROWAVE OVENS



**(57) Abstract:** An antenna cover assembly (11) for a high- temperature operating environment has a cover plate (23), gasket portions (25,39,41), and a retainer plate. The cover plate has an inner side and an outer side, the cover plate being translucent to at least one selected frequency of electromagnetic energy. The gasket portions are each located adjacent one of the inner and outer sides, each gasket portion being configured for sealingly engaging the adjacent side. The retainer plate is configured for attachment to a structure located in a high-temperature operating environment. The retainer plate has a sealing flange (33) adapted for clamping the cover plate generally adjacent an antenna portion (21) of a waveguide.

## ANTENNA COVER FOR MICROWAVE OVENS

**Cross Reference to Related Applications**

This application claims priority to U.S. Patent Application Serial No. 11/928,007 filed  
5 October 30, 2007, which claims priority to International Application No. PCT/US2005/035605 filed October 5, 2005; claims priority to U.S. Application No. 11/098,280 filed April 4, 2005; claims priority to International Application No. PCT/US2006/009075 filed March 14, 2006 and claims priority to U.S. Application Serial No. 11/392,050 filed March 29, 2006. The present application will be a continuation-in-part of  
10 U.S. Application Serial No. 11/098,280 filed April 4, 2005; will be a continuation-in-part of U.S. Application No. 10/614,268 filed July 7, 2003; will be a continuation-in-part of U.S. Application No. 10/614,532 filed July 7, 2003; and will be a continuation-in-part of U.S. Application No. 11/392,050 filed March 29, 2006.

The present application contains technical disclosure in common with International  
15 Application No. PCT/US2003/021225 filed July 5, 2003; contains technical disclosure in common with International Application No. PCT/US2005/007261 filed March 7, 2005; contains technical disclosure in common with U.S. Provisional Application No. 60/394,216 filed July 5, 2002; contains technical disclosure in common with PCT/US2004/035252 filed October 21, 2004; contains technical disclosure in common with International Application  
20 No. PCT/US2005/035605 filed October 5, 2005; contains technical disclosure in common with International Application No. PCT/US2006/009075 filed March 14, 2006; contains technical disclosure in common with U.S. Provisional Application No. 60/513,110 filed October 21, 2003; contains technical disclosure in common with U.S. Provisional Application No. 60/513,111 filed October 23, 2003; contains technical disclosure in common with U.S.  
25 Provisional Application No. 60/614,877 filed September 30, 2004; contains technical disclosure in common with U.S. Provisional Application No. 60/551,268 filed March 8, 2004; contains technical disclosure in common with U.S. Provisional Application No. 60/615,888 filed October 5, 2004; and contains technical disclosure in common with U.S. Provisional Application No. 60/550,578 filed March 5, 2004, the contents of all of the above-  
30 mentioned applications in their entireties are incorporated herein by reference.

### Field of the Invention

The present invention relates generally to covers for antennas and specifically to cover assemblies for slot antennas located within the cook chamber of an oven.

### Description of Related Art

5 A rapid-cook oven combines microwave (or radio frequency) cooking and convection cooking for cooking food products in a cook chamber. In one type of rapid-cook oven, the microwave portion comprises waveguides positioned along the left and right hand chamber walls. The covers (forming portions of cook chamber walls) of the waveguides are  
10 fitted with slotted antennas, which are slots formed in the waveguide cover. The slots are rectangular holes in the metal waveguides, and these may be, for example, approximately 2.39 inches long (6.07 cm) by approximately 0.25 inches wide (0.64 cm) (with rounded, or radiused, ends) for use with the energy frequency produced by 2.45GHz magnetron tubes. These antennas are associated with standard 2.45GHz magnetron tubes producing a  
15 maximum power level for the oven of around 1950 watts delivered to the food (or about 975 watts per tube). The number of slot antennas per side may vary, but current versions use 3 slot antennas per side.

The microwave slot antenna is within the cook chamber, and the antenna for a commercial oven may experience a maximum operating temperature of around 550°F  
20 (287.78° C). In addition, the antennas are open to the cooking chamber environment, so they must be sealed to prevent food particles, water, oil, cleaning agents, or other substances from being deposited in the waveguide. Contamination of the waveguide interior by such substances can reduce the life of the magnetron tube, reduce the useful power produced by the tube, and/or increase heat loss from the oven.

25 Although great strides have been made in the area of covers for microwave oven antennas, many shortcomings remain.

### Summary of the Invention

30 There is a need in the art for an improved cover for an antenna located within the cook chamber of an oven.

This object is achieved by providing an improved cover for an antenna located within the cook chamber of an oven.

An antenna cover assembly for a high-temperature operating environment has a cover plate, gasket portions, and a retainer plate. The cover plate has an inner side and an outer side, the cover plate being translucent to at least one selected frequency of electromagnetic energy. The gasket portions are each located adjacent one of the inner and outer sides, each gasket portion being configured for sealingly engaging the adjacent side. The retainer plate is configured for attachment to a structure located in a high-temperature operating environment. The retainer plate has a sealing flange adapted for clamping the cover plate generally adjacent an antenna portion of a waveguide.

### **Description of the Drawings**

The novel features believed to be characteristic of the invention are set forth in the appended claims. However, the invention itself, as well as a preferred mode of use, and further objectives and advantages thereof, will best be understood by reference to the following detailed description when read in conjunction with the accompanying drawings, wherein:

Figure 1 is a front view of a portion of a waveguide and cover assembly according to the invention, the figure showing a preferred embodiment of a cover according to the present invention;

Figure 2 is a cross-section view of the assembly of Figure 1 taken along the line 2-2;

Figure 3 is a front view of an alternative embodiment of a cover plate and gasket assembly according to the invention; and

Figure 4 is cross-section view of the assembly of Figure 3 taken along the line 4-4.

### **Description of the Preferred Embodiment**

The present invention is directed to an improved antenna cover for ovens that operate using electromagnetic energy, such as microwave or radio frequency (RF) energy, emitted through slot antennas located in a high-temperature cook chamber, such as in a combination microwave and convection oven.

To reliably seal the slot antennas and associated waveguides while providing a low loss (E/H energy) interface to the cooking cavity, the present invention provides a very durable and low-cost cover for slot antennas. The cover plate material must be compatible with a high-temperature operating environment (such as the interior of a convention oven),  
5 must be of low-loss characteristics relative to microwave (or RF) transmission, easily cleaned, durable, and inexpensive. Suitable cover plate, or window, material can be either flexible or rigid. For good microwave compatibility, materials with a dielectric constant less than approximately 6.0 and a loss tangent less than approximately 0.2 are preferred. In addition, the cover assembly must prevent moisture and/or grease from passing from the oven  
10 cavity to the interior of the waveguide.

Ceramic or rigid style cover plate materials include high-purity quartz and alumina. These materials have excellent high-temperature thermal characteristics, very good microwave transmission performance and offer good protection against user abuse. However, using these materials requires designs to be created with several considerations in  
15 mind.

For example, ceramic plates are susceptible to cracking or other damage if the window mounting structure that attaches the window to the oven cavity wall distorts, bends, or twists due to oven operation at an elevated temperature. When an oven wall made of sheet metal becomes hot, the wall distorts and can cause tensile stresses (primarily bending) in the  
20 ceramic window if the window is clamped directly to the cavity. In addition, these potential stresses increase as the size of the ceramic window increases.

Because ceramic cover plates have a very low coefficient of thermal expansion when compared to the oven sheet metal, another consideration is that bonding the ceramic directly to the sheet metal to create an edge seal is not effective for achieving a  
25 reliable, long-life seal. The seal is needed to prevent water and grease from seeping between the metal/ceramic interface, and a flexible interface gasket is required for good, long-life sealing. A further consideration is that high-purity ceramics are relatively expensive materials. To reduce material costs, the ceramics should cover only the slot antenna broadcast area and be as thin as possible.

30 Figures 1 and 2 are front and cross-section views of a portion of a waveguide and cover assembly 11. Waveguide 13 is installed within an oven cook cavity and comprises an outer wall 15 and an inner wall 17. Walls 15, 17 are preferably made from sheet metal

and are spaced from each other to form a waveguide cavity 19. Waveguide cavity 19 is in communication with a magnetron (not shown) or other electromagnetic energy emitter for guiding the emitted energy into the oven cavity. Slot antennas 21 are formed in inner wall 15 for permitting energy to be emitted through inner wall 17 into the cook cavity of the oven.

5 To prevent grease, food particles, or other materials within the oven cavity from entering waveguide cavity 19, ceramic cover plates, or windows 23, are located generally adjacent each slot antenna 21. In the embodiment shown, each window 23 is carried by a unitary o-ring gasket 25, which is retained in place by a cover plate 27. A peripheral edge of window 23 is sealingly carried in a groove 26, which is formed in an inner  
10 portion of gasket 25. Cover plate 27 is a rigid, generally planar member having flanges 29, 31 configured for attaching cover plate 27 to the oven wall. Cover plate 27 is preferably made from sheet metal, but may alternatively be made from other materials that are suitable for a high-temperature environment. For each slot antenna 21, a sealing flange 33 is formed in cover plate 27, each sealing flange 33 extending toward the oven cavity and having  
15 dimensions larger than those of slot antennas 21. Each sealing flange 33 has an inner rim 35 sized and configured for sealingly engaging gasket 25 about the periphery of window 23.

To seal windows 23 to waveguide 13, gasket 25 is clamped between rim 35 and inner surface 37 of inner wall 17. An inner sealing interface 39 is formed between gasket 25 and rim 35, and an outer sealing interface 41 is formed between gasket 25 and surface 37  
20 of inner wall 17. This allows gasket 25 to provide sealing interfaces 39, 41 to prevent grease, moisture, or other matter from entering waveguide 13 from the oven cavity and provide a compliant foundation for accommodating local twisting, bending, and displacement of the associated sheet metal components. This foundation greatly reduces bending stresses on each window 23. In addition, the use of a separate smaller window for each slot antenna 21, as  
25 compared to a large sheet of material covering all slot antennas 21, reduces material costs and further reduces stress in windows 21 by permitting windows 21 to translate and rotate relative to each other. Sealing interfaces 39, 41 create a redundant sealing geometry, such that any grease, water, or cooking residue must pass by both sealing interfaces 39, 41 before entering slot antenna 21 and waveguide 13.

30 Sealing flanges 33, which are spaced from inner wall 17, may act as reflectors to an energy beam 43 (with side lobes) emitted from slot antenna 21. Therefore, windows 23 must have enough viewing area relative to energy beam 43 to permit beam 43 to radiate from each antenna 21 with minimal reflection of power back to antennas 21. Figures 3 and 4 are

enlarged views of an alternative embodiment of an assembly according to the invention. Window 45 is shown assembled with gasket 47, a groove 49 in gasket 47 sealingly engaging the peripheral edge of window 45. Figure 4 is a cross-section view showing the assembly of window 45 and gasket 47 adjacent an inner surface 51 of an inner wall 53 of a waveguide, window 45 being located over a slot antenna 55.

In the embodiment shown, a clearance distance 57 from between inner surface 51 and window 47 is preferably less than approximately 0.375 in., and the thickness of window 47 is preferably less than approximately 0.125 in. As shown in Figure 3, slot antenna 55 has a length dimension 59 of approximately 2.4 in. and a width dimension 61 of 0.25 in. To limit or eliminate reflection of energy emitted through antenna 55, window 47 is sized to have a preferred length dimension of length dimension 63 of approximately 3.5 in. and a width dimension 65 of 2.5 in.

While shown in the embodiments as being a unitary gasket, the gasket that carries the windows may be formed as two pieces. In this configuration, at least one gasket piece is located between the rim of the sealing flange and the oven cavity side of the window, and at least one gasket piece is located between the inner surface of the waveguide inner wall and the waveguide side of the window.

While exemplary embodiments of the present invention have been shown and described, it will be understood that various changes and modifications to the foregoing embodiments may become apparent to those skilled in the art without departing from the spirit and scope of the present invention. Accordingly, the invention is not limited to the embodiments disclosed, but rather by the appended claims and their equivalents.

### Claims

1. An antenna cover assembly for a high-temperature operating environment, comprising:
- 5 a cover plate having an inner side and an outer side, the cover plate being translucent to at least one selected frequency of electromagnetic energy;
- at least two elastomeric gasket portions, each portion being located adjacent one of the inner and outer sides, each gasket portion being configured for sealingly engaging the adjacent side;
- 10 a retainer plate adapted for attachment to a structure located in a high-temperature operating environment, the retainer plate having a sealing flange adapted for clamping the cover plate generally adjacent an antenna portion of a waveguide.
2. The antenna cover assembly according to claim 1, wherein the at least two gasket
- 15 portions are carried by a unitary gasket.
3. The antenna cover assembly according to claim 1, wherein the at least two gasket portions are carried by a unitary gasket, the gasket having an inner groove configured for engaging a periphery of the cover plate.
- 20 4. The antenna cover assembly according to claim 1, wherein the sealing flange has a rim offset from a plane of the antenna portion.
5. The antenna cover assembly according to claim 1, wherein the cover plate is formed
- 25 from a ceramic material.
6. An antenna cover assembly for a microwave oven, comprising:
- a waveguide having an inner wall and an antenna formed in the inner wall, the waveguide being adapted for attachment in an oven;
- 30 a cover plate having an inner side and an outer side, the cover plate being translucent to at least microwave frequency energy;
- at least two elastomeric gasket portions, each portion being located adjacent one of the inner and outer sides, each gasket portion being configured for sealingly engaging the adjacent side;



a retainer plate having a sealing flange for clamping the cover plate generally adjacent the antenna.

5 7. The antenna cover assembly according to claim 6, wherein the at least two gasket portions are carried by a unitary gasket.

8. The antenna cover assembly according to claim 6, wherein the at least two gasket portions are carried by a unitary gasket, the gasket having an inner groove configured for engaging a periphery of the cover plate.

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9. The antenna cover assembly according to claim 6, wherein the sealing flange has a rim offset from a plane of the antenna.

10. The antenna cover assembly according to claim 6, wherein the cover plate is formed  
15 from a ceramic material.

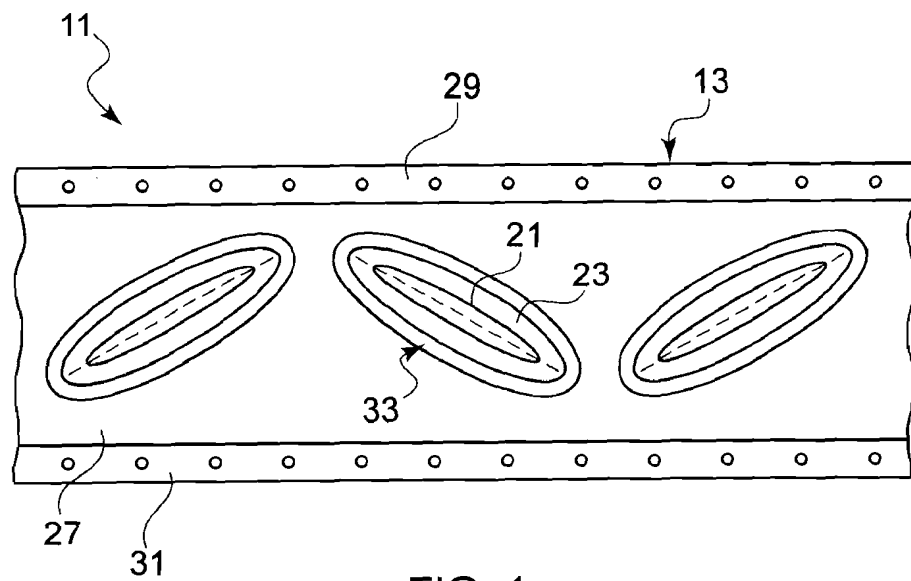


FIG. 1

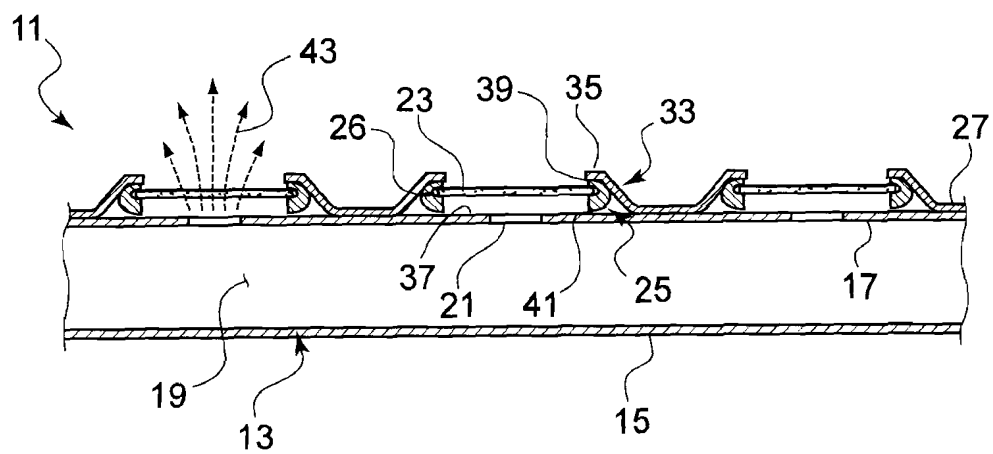


FIG. 2

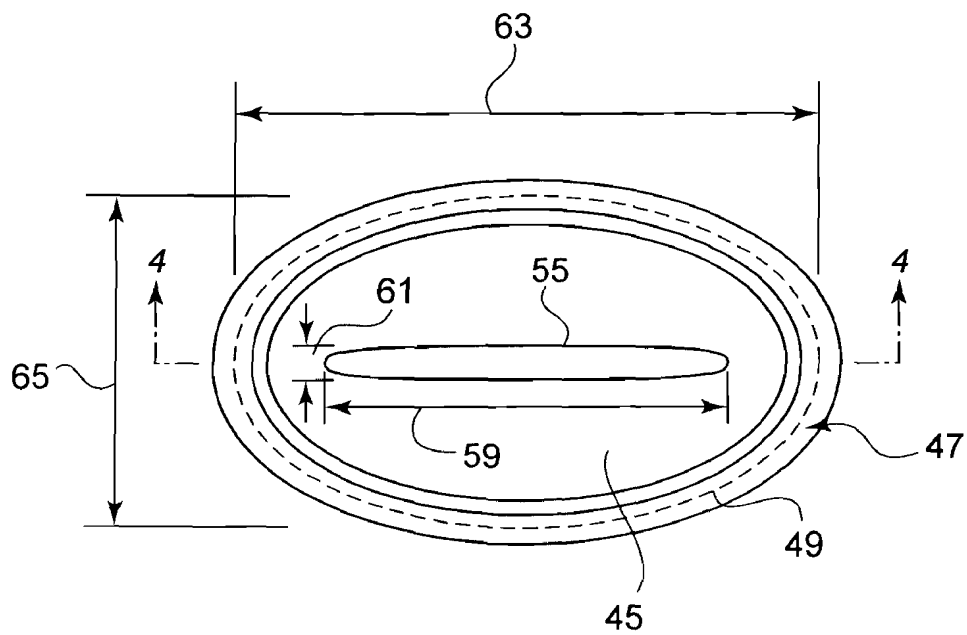


FIG. 3

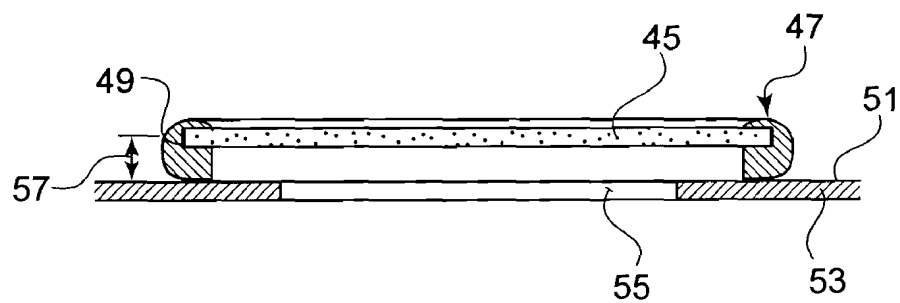


FIG. 4

# INTERNATIONAL SEARCH REPORT

International application No

PCT/US2008/081689

**A. CLASSIFICATION OF SUBJECT MATTER**  
 INV. H01Q1/42 H05B6/72  
 ADD. F24C7/02

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

H01Q H05B F24C A21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, INSPEC, COMPENDEX, IBM-TDB

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	DE 31 19 596 A1 (LICENTIA GMBH [DE]) 2 December 1982 (1982-12-02) page 4, line 11 - line 25 figure 1 abstract	1-10
Y	----- US 4 316 069 A (FITZMAYER LOUIS H) 16 February 1982 (1982-02-16) column 3, line 26 - column 5, line 20 figures 1-5 abstract	1-10
Y	----- JP 62 218736 A (MATSUSHITA ELECTRIC IND CO LTD) 26 September 1987 (1987-09-26) figures 1-11 abstract	1-10
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Further documents are listed in the continuation of Box C.



See patent family annex.

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\*X\* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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# INTERNATIONAL SEARCH REPORT

International application No  
PCT/US2008/081689

## C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	US 2007/194011 A1 (MCFADDEN DAVID H [US]) 23 August 2007 (2007-08-23) page 3, paragraph 35 - page 6, paragraph 57 figures 1-11 abstract -----	1-10
A	WO 2005/087009 A (GLOBAL APPLIANCE TECHNOLOGIES [US]; MCFADDEN DAVID H [US]) 22 September 2005 (2005-09-22) cited in the application page 32, line 10 - page 33, line 16 figures 8,9 abstract -----	1-10

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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